World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:13, No:03, 2019

Enhancing Efficiency of Building through Translucent Concrete

Authors : Humaira Athar, Brajeshwar Singh

Abstract : Generally, the brightness of the indoor environment of buildings is entirely maintained by the artificial lighting which has consumed a large amount of resources. It is reported that lighting consumes about 19% of the total generated electricity which accounts for about 30-40% of total energy consumption. One possible way is to reduce the lighting energy by exploiting sunlight either through the use of suitable devices or energy efficient materials like translucent concrete. Translucent concrete is one such architectural concrete which allows the passage of natural light as well as artificial light through it. Several attempts have been made on different aspects of translucent concrete such as light guiding materials (glass fibers, plastic fibers, cylinder etc.), concrete mix design and manufacturing methods for use as building elements. Concerns are, however, raised on various related issues such as poor compatibility between the optical fibers and cement paste, unaesthetic appearance due to disturbance occurred in the arrangement of fibers during vibration and high shrinkage in flowable concrete due to its high water/cement ratio. Need is felt to develop translucent concrete to meet the requirement of structural safety as OPC concrete with the maximized saving in energy towards the power of illumination and thermal load in buildings. Translucent concrete was produced using pre-treated plastic optical fibers (POF, 2mm dia.) and high slump white concrete. The concrete mix was proportioned in the ratio of 1:1.9:2.1 with a w/c ratio of 0.40. The POF was varied from 0.8-9 vol.%. The mechanical properties and light transmission of this concrete were determined. Thermal conductivity of samples was measured by a transient plate source technique. Daylight illumination was measured by a lux grid method as per BIS:SP-41. It was found that the compressive strength of translucent concrete increased with decreasing optical fiber content. An increase of ~28% in the compressive strength of concrete was noticed when fiber was pre-treated. FE-SEM images showed little-debonded zone between the fibers and cement paste which was well supported with pull-out bond strength test results (~187% improvement over untreated). The light transmission of concrete was in the range of 3-7% depending on fiber spacing (5-20 mm). The average daylight illuminance (~75 lux) was nearly equivalent to the criteria specified for illumination for circulation (80 lux). The thermal conductivity of translucent concrete was reduced by 28-40% with respect to plain concrete. The thermal load calculated by heat conduction equation was ~16% more than the plain concrete. Based on Design-Builder software, the total annual illumination energy load of a room using one side translucent concrete was 162.36 kW compared with the energy load of 249.75 kW for a room without concrete. The calculated energy saving on an account of the power of illumination was ~25%. A marginal improvement towards thermal comfort was also noticed. It is concluded that the translucent concrete has the advantages of the existing concrete (load bearing) with translucency and insulation characteristics. It saves a significant amount of energy by providing natural daylight instead of artificial power consumption of illumination.

Keywords : energy saving, light transmission, microstructure, plastic optical fibers, translucent concrete
Conference Title : ICTCR 2019 : International Conference on Translucent Concrete Research
Conference Location : Tokyo, Japan
Conference Dates : March 25-26, 2019